IEEE P802.15
Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)		
Title	**New Text for Clauses 9 and 11**		
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Abstract [This contribution presents new text for Clauses 9 and 11. The text given here is presented a replacement to what is currently in the draft recommended practices document]

Purpose [The new text for clauses 9 and 11 is provided for inclusion in the recommended practices document.]

Clause 9. Data Traffic Models

For Bluetooth, we consider two types of applications, namely voice and data traffic. For voice, we assume a symmetric stream of 64 kbits/s each way using HV1 packet encapsulation. For data we use DH5 packets. The packet interarrival time is exponentially distributed, and its mean in seconds is computed according to

$$t_b = 2 * N * T_s / l,$$

where l is the offered load; N is the number of slots occupied by a packet. For DH5, N=5. T_s is the slot size equal to 625μs.
For the WLAN, the packet payload is fixed to 12,000 bits and l is varied. The packet interarrival time in seconds, t_w is exponentially distributed, and its mean is computed according to

$$t_w = ((192/1,000,000) + (12,224/payload\_data\_rate))/l,$$

where the 192-bit PLCP header is sent at 1 Mbits/s and the payload_data_rate is either 1 or 11 Mbits/s.

Clause 11: Coexistence Modeling Results

We present simulation results to evaluate the performance of Bluetooth in the presence of WLAN interference and vice versa. All simulations are run for 30 seconds of simulated time. The performance measurements are logged at the slave device for Bluetooth and at the Mobile device for the WLAN. The mean access delay result is normalized by the mean delay when no interference is present. We use the configuration and system parameters shown in Table 1.

Simulation Parameters	Values
Length of simulation run	30 seconds
Bluetooth Parameters	Values
Data Packet Interarrival Time	12.5 ms
ACL Baseband Packet Encapsulation	DH5
SCO Baseband Packet Encapsulation	HV1
Transmitted Power	1 mW
Slave Coordinates	(0,0) meters
Master Coordinates	(1,0) meters
WLAN Parameters	
Packet Interarrival Time for 1 Mbits/s	24.8 ms

Packet Interarrival Time for 11 Mbits/s	2.6 ms
Transmitted Power	25 mW
AP Coordinates	(0,15) meters
Mobile Coordinates	(0,d) meters
Packet Header	224 bits

Table 1: Simulation Parameters

We present the results from four different simulation experiments that show the impact of WLAN interference on Bluetooth devices and vice versa for two different applications, namely voice and data traffic. Table 3 provides a summary of these four cases, while Figure 2 shows the experimental topology. Please note that the WLAN access point (AP) is fixed at (0,15) meters, while the WLAN mobile is free to move along the vertical axis, i.e. its coordinates are (0,d). The Bluetooth devices are fixed at the given locations. In the first two experiments, the mobile is the generator of the 802.11 data, while the AP is the sink. In the last two experiments the traffic is generated at the AP.

Experiment	Desired Signal	Interferer Signal	WLAN AP	WLAN Mobile
1	BT Voice	802.11	Sink	Source
2	BT data	802.11	Sink	Source
3	802.11	BT Voice	Source	Sink
4	802.11	BT data	Source	Sink

Table 2: Summary of the Experiments

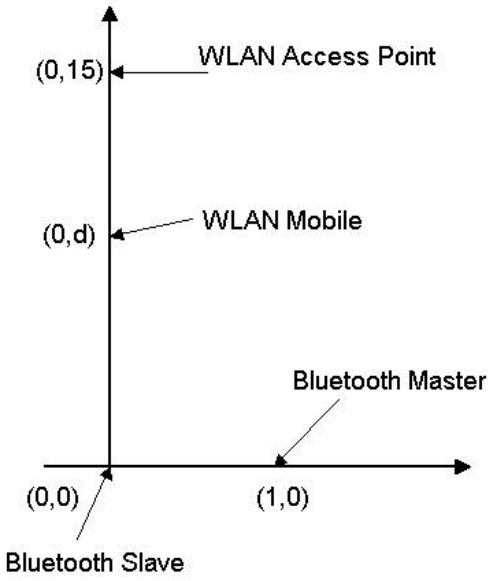

Figure 1: Experiment Topology

All four experiments are repeated for 802.11 1 Mbits/s and 11 Mbits/s Direct Sequence Spread Spectrum (DSSS) and 1 Mbits/s Frequency Hopping (FH) systems.

Clause 11.1 802.11 1 Mbits/s Direct Sequence and Bluetooth Interference

Scenarios 1 and 2

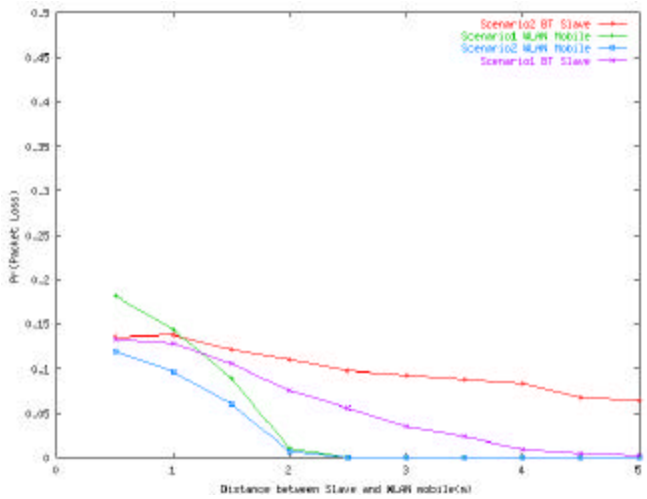

Figure 2: Probability of Packet Loss - 1 Mbits/s Direct Sequence

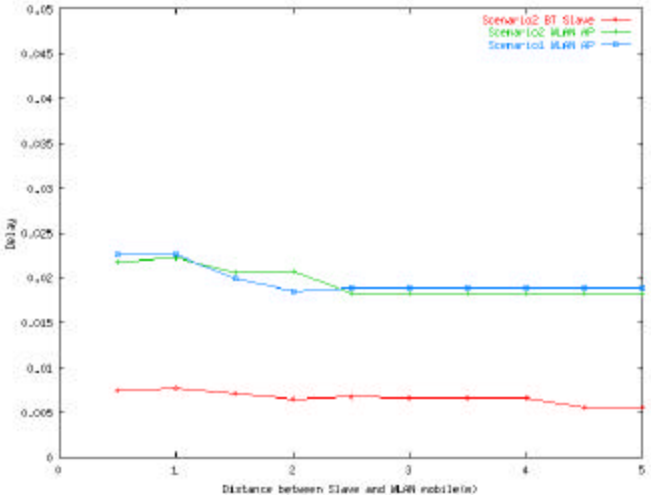

Figure 3: Access Delay (seconds) - 1 Mbits/s Direct Sequence

Scenarios 3 and 4

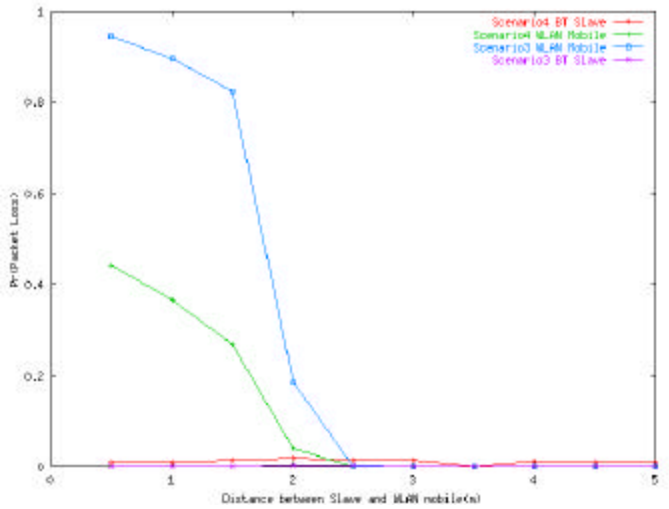

Figure 4: Probability of Packet Loss - 1 Mbits/s Direct Sequence

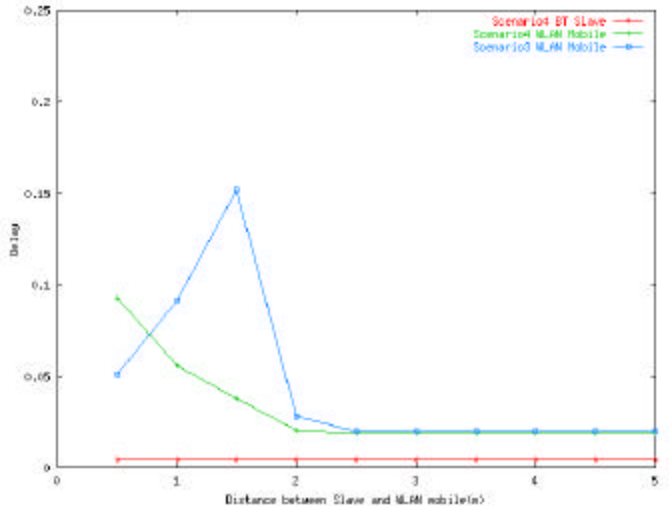

Figure 5: Delay (seconds) - 1 Mbits/s Direct Sequence

Clause 11.2 802.11 11 Mbits/s Direct Sequence and Bluetooth Interference

Scenarios 1 and 2

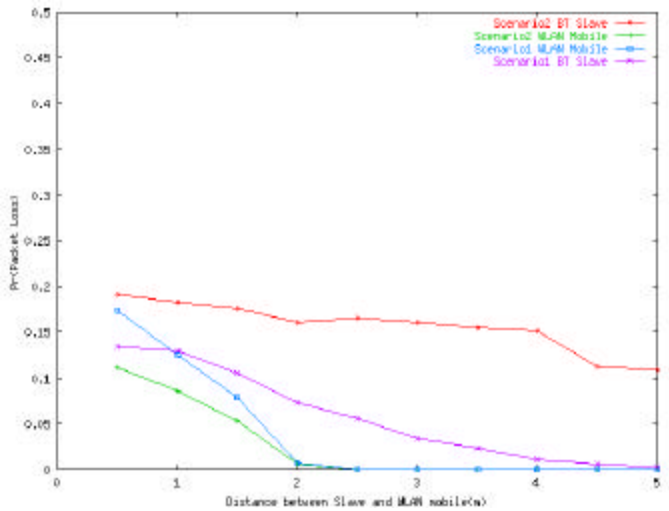

Figure 6: Probability of Packet Loss - 11 Mbits/s Direct Sequence

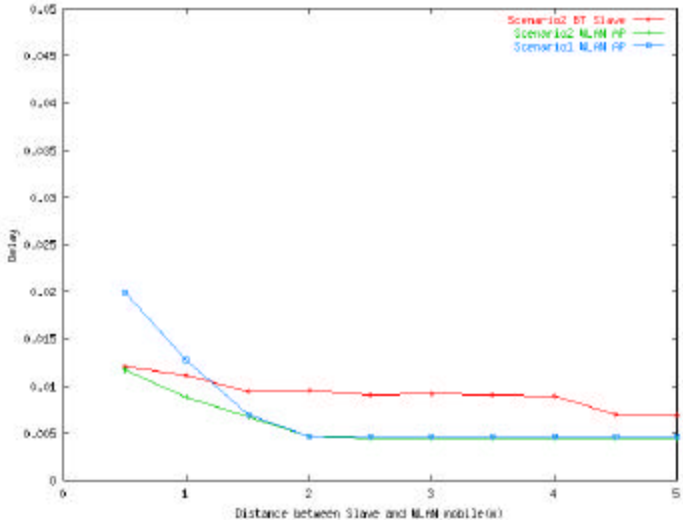

Figure 7: Access Delay (seconds) - 11 Mbits/s Direct Sequence

Scenarios 3 and 4

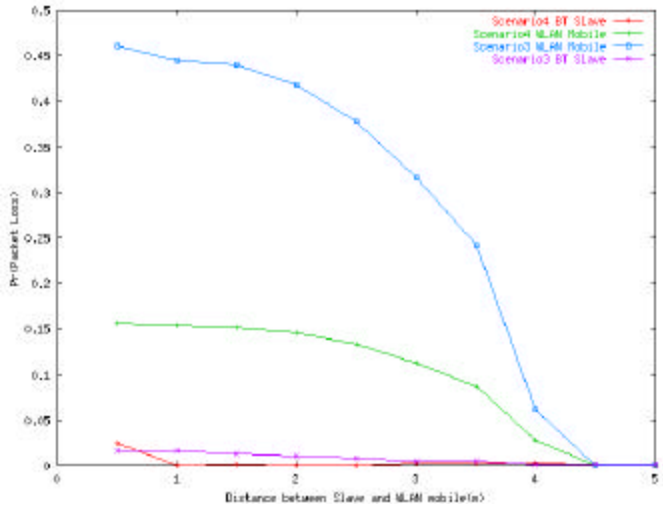

Figure 8: Probability of Packet Loss - 11 Mbits/s Direct Sequence

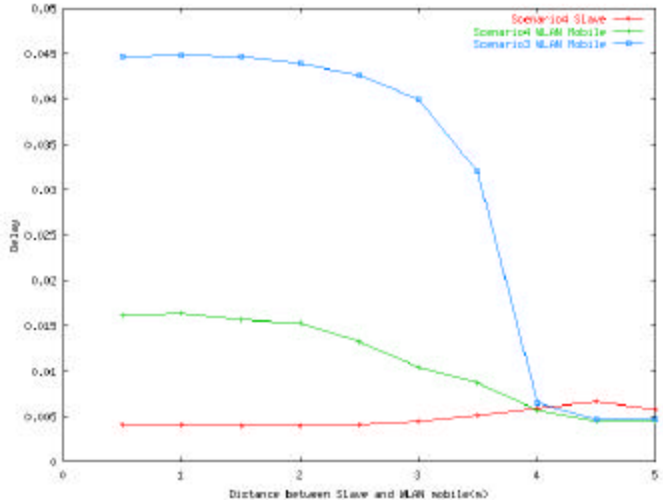

Figure 9: Access Delay (seconds) - 11 Mbits/s Direct Sequence

Clause 11.3 802.11 1 Mbits/s Frequency Hopping and Bluetooth Interference

Scenarios 1 and 2

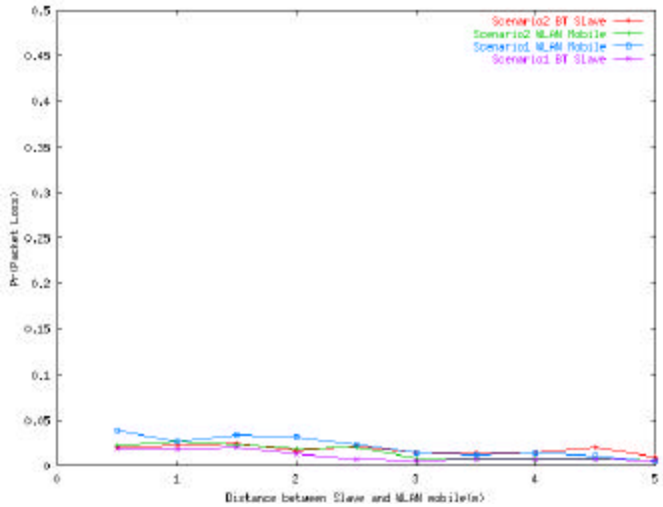

Figure 10: Probability of Packet Loss - 1 Mbits/s Frequency Hopping

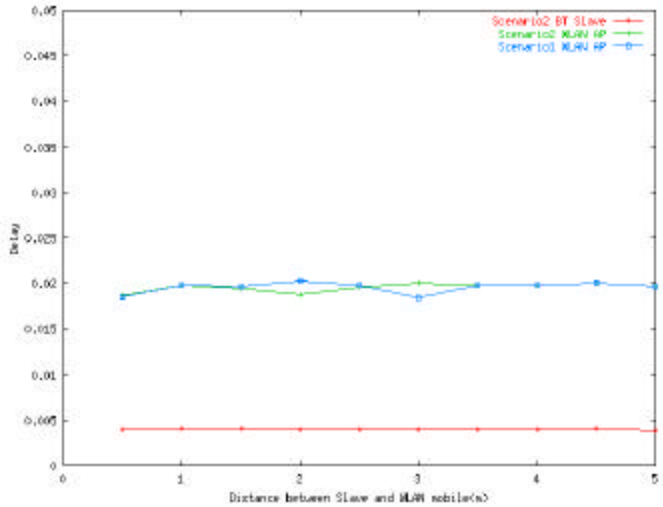

Figure 11: Access Delay (seconds) - 1 Mbits/s Frequency Hopping

Scenarios 3 and 4

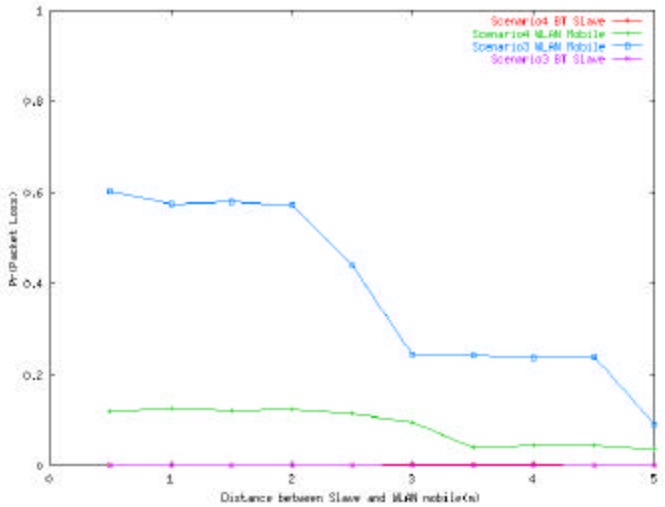

Figure 12: Probability of Packet Loss - 1 Mbits/s Frequency Hopping

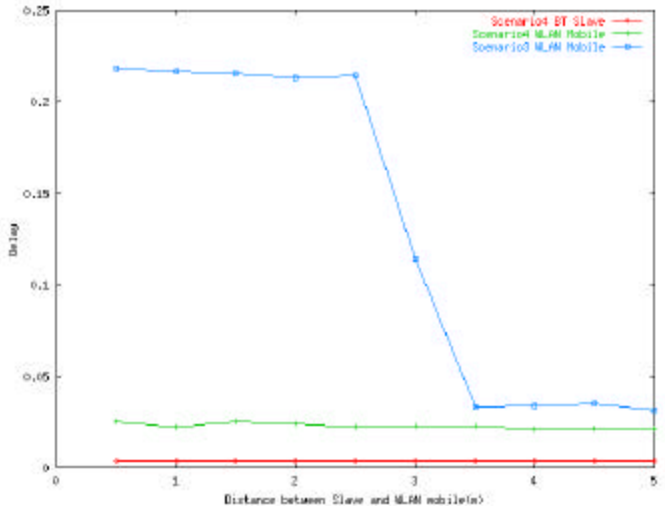

Figure 13: Delay (seconds) - 1 Mbits/s Frequency Hopping